AD-A166 990 AUTOMATIC ORBITAL WELDING HEAD FOR SHIPBOARD USE WHERE ACCESSIBILITY IS LIMITED(U) ASTRO ARC CO SUN VALLEY CA L E WAGNER ET AL. 1986 N00140-82-C-B977 1/1

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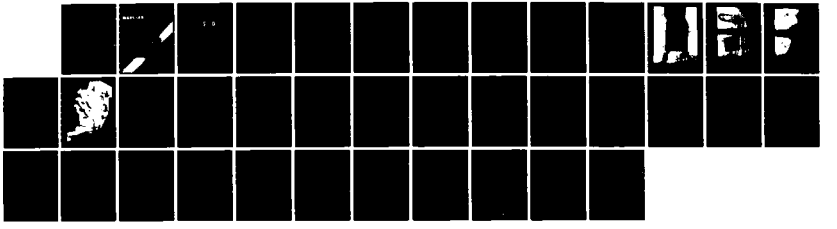

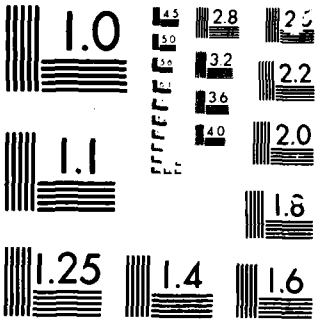

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NAVSSES

AUTOMATIC ORBITAL WELDING HEAD

FOR

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PHILADELPHIA, PA 19112

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AUTOMATIC ORBITAL WELDING HEAD

FOR

SHIPBOARD USE WHERE ACCESSIBILITY IS LIMITED

INTERIM REPORT

SEPTEMBER 82 – SEPTEMBER 83

A PROJECT OF THE
NAVAL SEA SYSTEMS COMMAND
MANUFACTURING TECHNOLOGY PROGRAM
AND OF PMS 301

BY

L. E. WAGNER AND R. D. HARRIS
NAVSSES

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20. ABSTRACT (continued from block 20 of DD Form 1473)

This project used test welds to demonstrate the automatic welding of "U" bends to a simulated bank of economizer tubes. This welding was accomplished using a prototype head designed to fit within the limited space available. A mock-up simulated a section of the economizer tube bank for the Frigate USS Downes (FF 1070). A remote control system was also developed for the prototype head.

In this welding operation, the "U" bend is first fitted up with Electric Boat (EB) consumable inserts and tack welded. The EB insert is then fused using the pulsed current Gas Tungsten Arc Welding (GTAW) method with the prototype head. A two piece "outsert" is then tack welded over the root pass. The joint is completed by making a pair of fusion passes over the "outsert" with the head.

Delivery of the prototype head was made to NAVSSES after the contractor completed an abbreviated series of qualifications tests including liquid penetrant, radiographic and metallurgical analyses. Plans to continue with a full series of qualification tests were postponed because Navy approved joint designs had not yet provided allowances for use of devices like the "outserts".

A design of an alternate head for the "U" bend application was developed with a partially open head to faciliate weld head installation and observation. An automatic cold wire feed system was added to eliminate the use of the outsert. This alternate head was not build or tested under the work covered by this interim report.

FOREWORD

The project reported herein was sponsored by the Naval Sea Systems Command (NAVSEA 05R4 and PMS 301). The work was conducted under Project DNS-50013.

The need for several automatic orbital welders for limited space application has been identified. The work reported in this interim report focused on one specific welding application, the repair of economizer tubes.

Work was conducted by Astro-Arc Co. under Navy contract number N00140-82-C-B977. Acceptance tests were performed at Astro-Arc Co., Sun Valley, CA and witnessed by Mr. L. Noble, NAVSSES 032D, and Mr. Herbert, DCASMA, Van Nuys, CA.

EXECUTIVE SUMMARY

Naval Shipyards use commercially available, automatic, orbital welding equipment for repairing piping and boiler tubing. Unfortunately, the standard "heads" for such equipment are too bulkly for many critical repair needs. NAVSEA PMS 301 and Code 05R4 cooperated in the development of a compact orbital welding head for repairing economizer "U" bend joints.

The portion of the Project funded by PMS 301 developed a prototype head and a remote control system. This system completes "root" passes in a conventional manner but requires the installation of consumable "outserts" for completing the "fill" passes. The development of the Astro-Arc Model 2124 automatic welding head demonstrated that state-of-the-art automatic pipe/tube welding techniques can be miniaturized to weld hard-to-reach joints. Plans to continue with a full series of qualifications tests for the Model 2124 head were postponed because Navy approved joint designs had not yet provided allowances for use of devices like the "outsert".

The portion of the work funded by Code 05R4 developed a design of an alternate head for the "U" bend application with a partially open head to faciliate weld head installation and observation. An automatic cold wire feed system was added to eliminate the use of the outsert. This alternate head was not build or tested under the work covered by this interim report.

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DEVELOPMENT OF PROTOTYPE WELDING HEADS

OBJECTIVE

The technical objective of this project was the development of an automatic orbital welding head for use in the confined spaces, around boiler economizer "U" bend joints.

BACKGROUND

The repair of the economizers on Navy ships presents difficulties to the shipyards. Tubes are replaced and "U" bends are fitted-up and welded in place to restore the horizontal tubes bundles. These "U" bend joints are difficult to reach and, in addition, the tubes are closely packed. The manual shielded metal arc method of completing these welds is time consuming and the risk of defects is high. As discussed in the Executive Summary, miniaturized "heads" are required to complete such welds automatically.

A contract was awarded to Astro-ARC Inc. to develop a simplified, miniaturized orbital head to fit within the space limitation of a mock-up specified by NAVSSES. This mock-up simulated a section of the 2-inch economizer tube bank designed by CE for the Frigate USS DOWNES FF 1070.

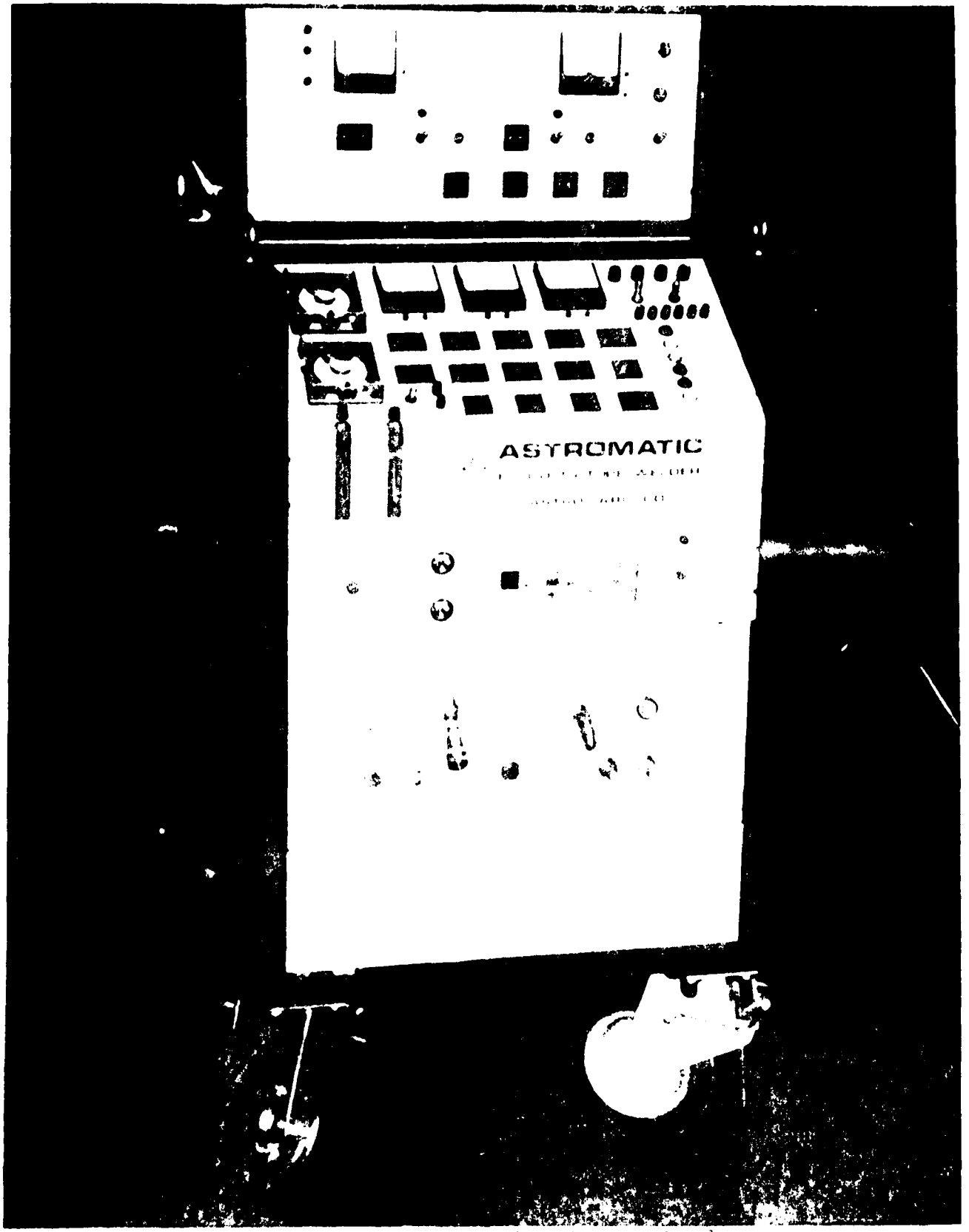
As the contract proceeded it was apparent that success with the simplified head would not be sufficient to meet the Navy's needs. The contract was therefore extended to include a feasibility study consisting of the design of a second generation "open" head with space for a cold wire feed.

This report describes in detail the development of the simplified prototype, the Astro-Arc 2124 head, and discusses the feasibility phase of the development of a more conventional second generation compact head.

DESCRIPTION OF SEMI-AUTOMATED WELDING OF ECONOMIZER TUBES

New tubes with the ends already prepared are installed in the economizer and aligned prior to welding. The tube repair welding sequence is substantially unchanged except for the use of automatic welding equipment.

A power supply, such as an Astro-Arc E-200-TA unit, the remote control unit and the model 2124 head will be required for automatic welding. The 2124 head will also require torch shielding gas and cooling water. The operation will require additional shielding gas (for the water sides of the tubes) and a manual torch for tacking welding. Figure 1 shows the power supply. Figure 2 shows the welding head with connections and remote controls. Figure 3 shows a close up of a welded joint, an EB insert and a 2-piece "outsert".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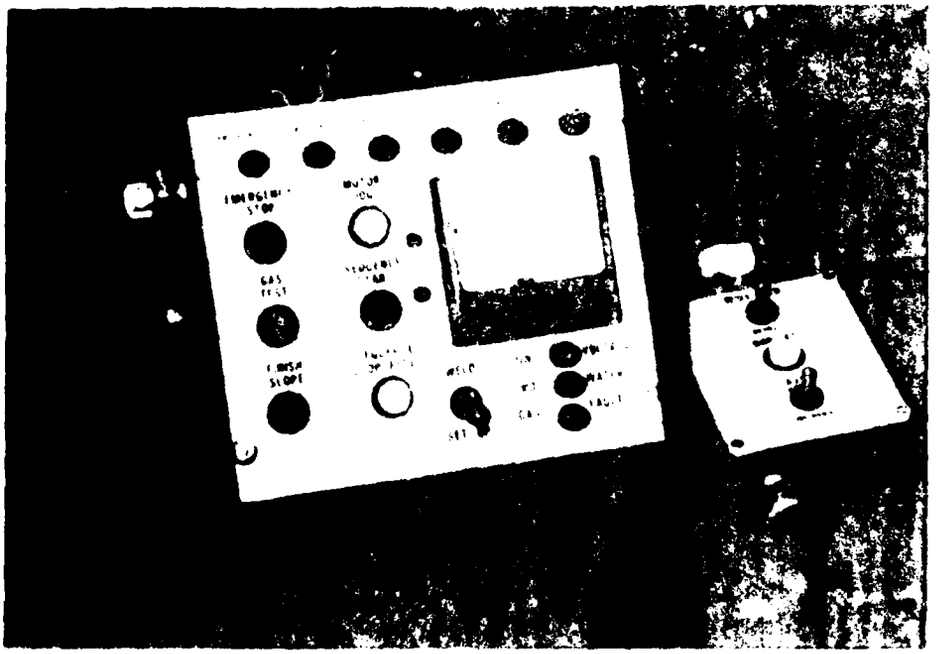

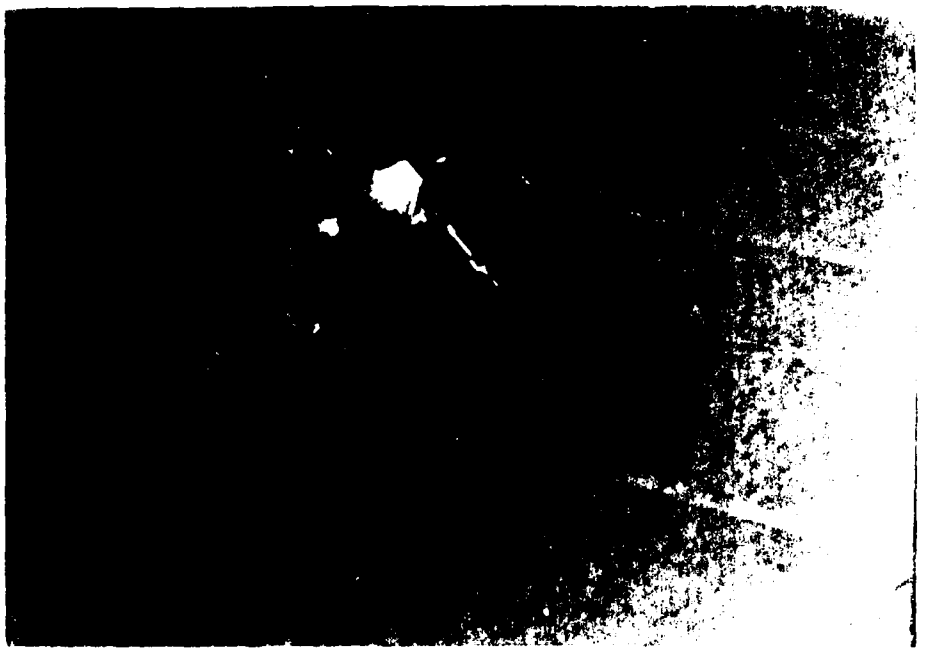

Detailed repair procedures will be developed by each shipyard as part of the qualification procedure. In general terms: (1) each "U" bend will be fitted-up using EB inserts and tack welded; (2) shielding gas will be connected to the water side of the tubes; and (3) a multi-step procedure will be followed to fuse the inserts, install the "outserts", and fuse the "outserts".

EVALUATION OF MODEL 2124 PROTOTYPE HEAD

1. Deliverables

The followings deliverables were required under the initial contract:

a. Proven, prototype orbital head
b. Remote controls and connections to E-200-TA power supply
c. Completed test welds including inspection
d. Additional "mock-up" and "outserts"

2. Operation of 2124 Welding Head

In order to weld "U" tubes to economizer joints, the 2124 welding head has to be set up in available clearances at the end of the tube bundle as shown in Figure 4.

The welding procedure is given in Appendix A. It is summarized below with the aid of figures 5, 6 and 7. Figure 5 shows the prototype welding head assembly and Figure 6 the alignment tool. Prior to setting-up, the "knurled screw" in Figure 5 is loosened, the "latch" is released and the clamp assembly is removed. The clamp assembly is placed in position, located with the aid of the alignment tool and clamped in position. Figure 7 shows a typical set-up of the clamp.

In summary, the multiple step procedure is as follows:

(1) With the aid of the alignment tool, set tube clamp in location and orient the clamp for fusing EB insert. Remove alignment tool leaving the clamp in position.

(2) Locate head assembly on clamp; close latch; and secure in place using "knurled screw".

(3) Automatically fuse the EB insert.

(4) Remove head and tube clamp; check fused EB ring.

(5) Fit up and tack weld "outsert".

(6) Set tube clamp as in step (1) for first fusion pass on the "outsert".

(7) Locate head assembly as in step (2).

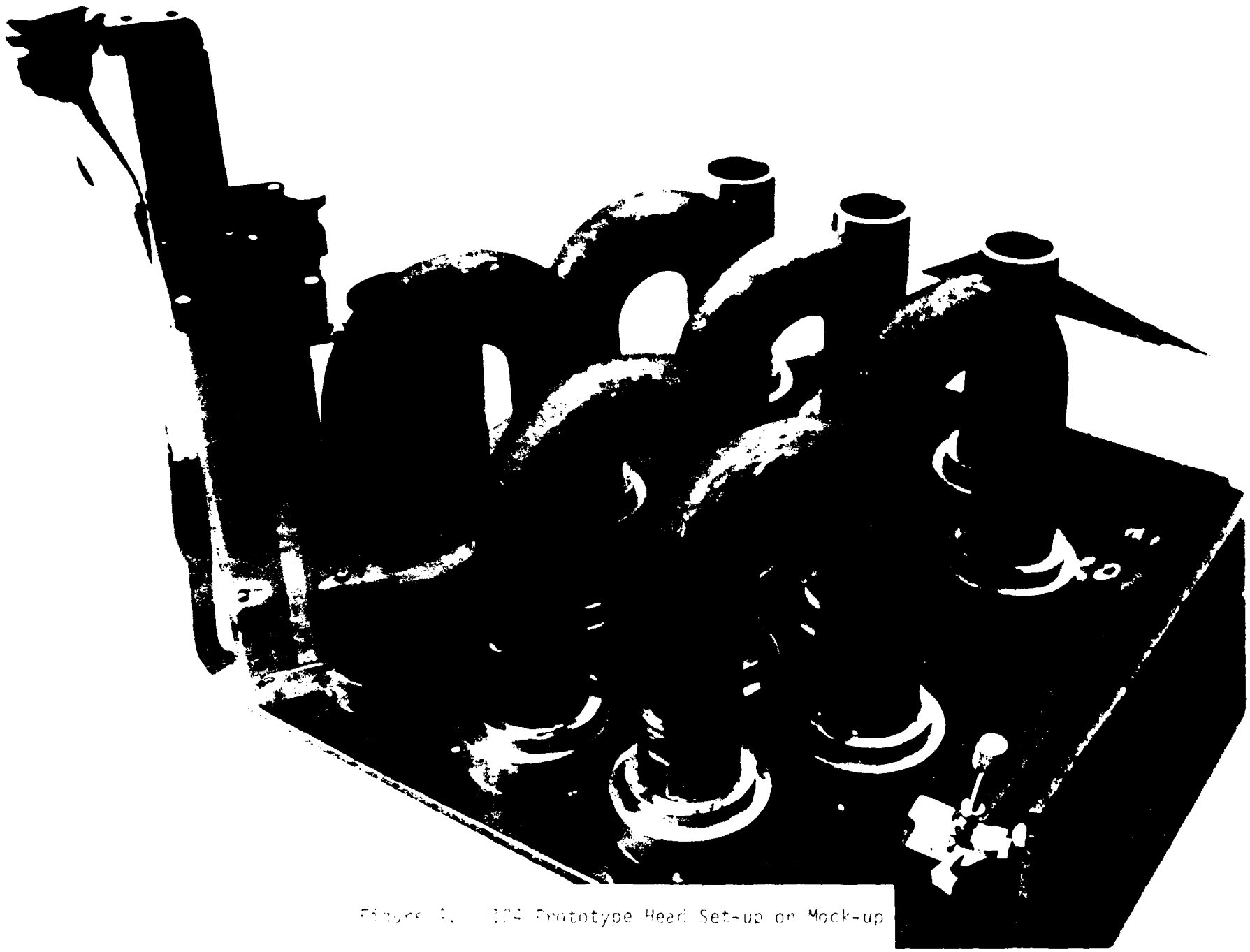

Figure 1. 1124 Prototype Head Set-up on Mock-up

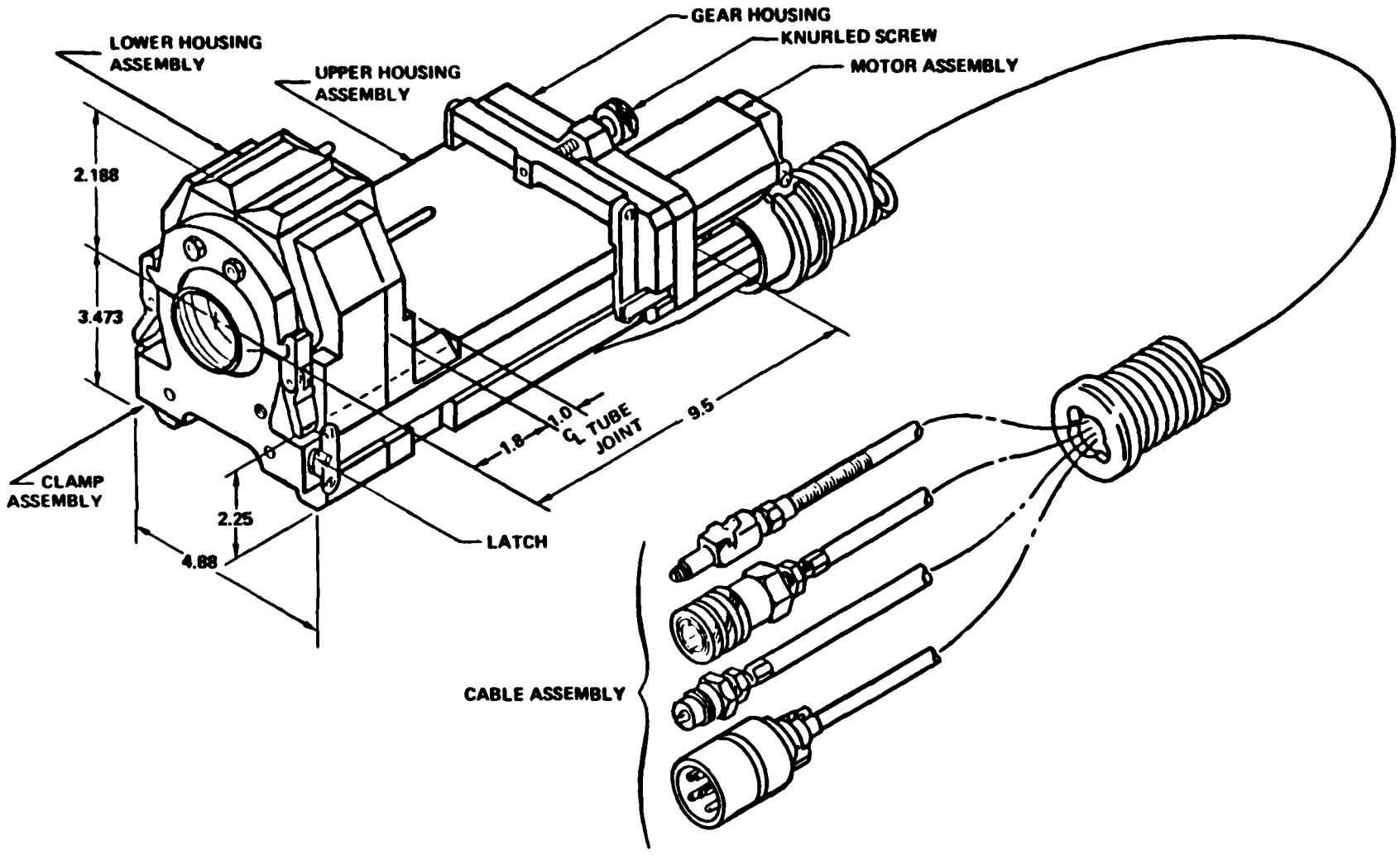

Figure 5. Isometric View of Model 2124 Prototype Weld Head

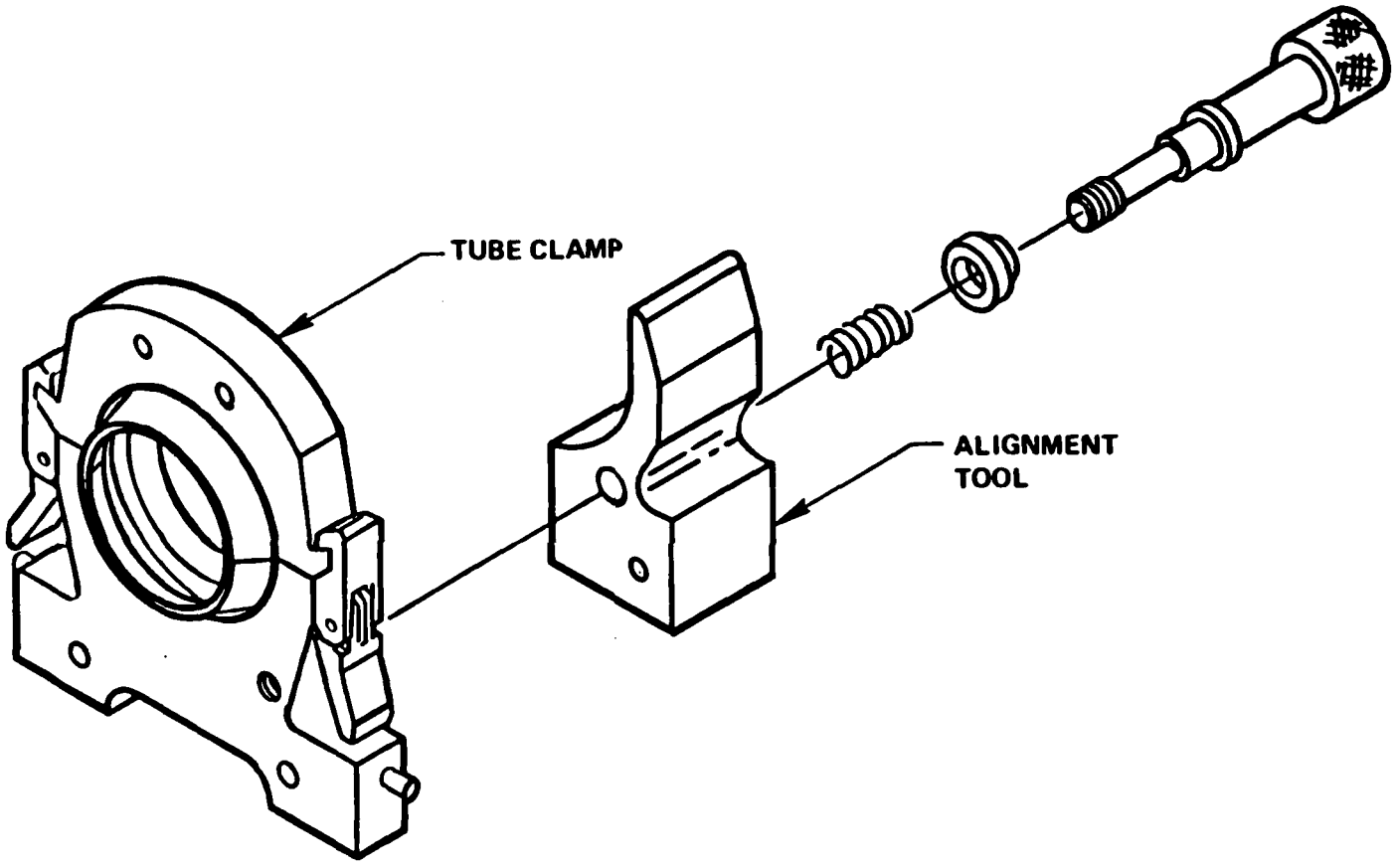

Figure 6. Isometric View of Tube Clamp and "Exploded" Alignment Tool

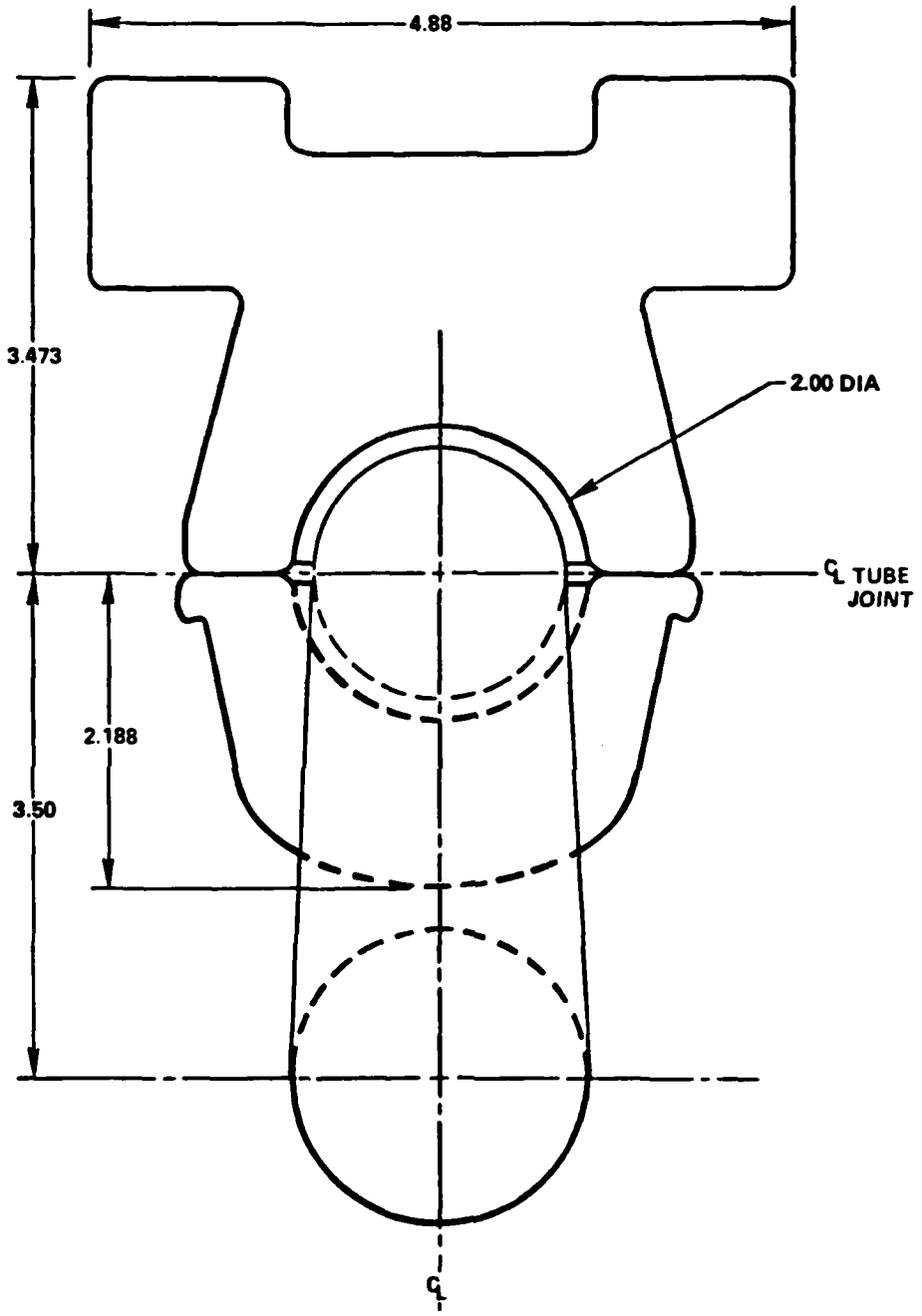

Figure 7. End Elevation of Tube Clamp in Position Prior to Connecting Weld Head

(8) Automatically fuse the first pass of "outsert".

(9) Remove head from clamp.

(10) Reset clamp as in step (6) for second fusion pass.

(11) Relocate head as in steps (2) and (7).

(12) Automatically fuse second pass.

(13) Remove head and clamp from the completed joint.

3. Acceptance Tests

The performance of the Model 2124 orbital welding head was witnessed by Mr. Lester Noble, NAVSSES Code 032D, at Astro-Arc Inc., Sun Valley, California. Six sections of "U" bend to tube joints were welded using the EB insert for the root pass and the Astro-Arc designed outer ring ("outsert") for the fill passes. Two of the six welded sections were cut to provide macro specimens. The macro specimens, examined using 5X magnification, met the requirements of MIL-STD-248D.

The final acceptance test were witnessed by Mr. Noble and a DCASMA Van Nuys, California representative. These welds were made 24 March 1983 and 1 April 1983 using an Astro-Arc furnished economizer "U" bend weld joint mock-up that consisted of six 2-inch diameter bends (total of 12 welds). The material was MIL-T-16286, S 1 (2-inch diameter, 0.180-inch wall).

Liquid penetrant and radiographic inspections were conducted on 8 April 1983 by Commercial Inspection Service of Burbank, California and witnessed by a DCASMA source inspector. The inspection was conducted in accordance with MIL-STD-271E and MIL-STD-278D using NAVSHIPS 0900-003-8000 Class one acceptance standards for penetrant inspection and NAVSHIPS 0900-033-9000 Class one acceptance standards for radiographic inspection. All welds were acceptable according to the liquid penetrant inspection. Four welds were rejected by the radiographic inspection. The unacceptable welds and causes for rejection are given in Table 1.

Table 1. Inspection Test Results

WELD NO.	FILM NO.	UNACCEPTABLE POROSITY	CRACKS
1A	V1	X	-----
5B	V1	X	X
6A	V2	X	-----
6B	V1	-----	X

The final passes of the four rejected welds were rewelded (without removal or addition of metal). All four welds were acceptable according to the liquid penetrant inspection but one weld was rejected again because of porosity according to the radiographic inspection. The final pass of this rejected weld was again rewelded, was inspected as before and was then acceptable by both liquid penetrant and radiographic inspection.

In production, these welds would be liquid penetrant inspected or visually inspected at 5X magnification after the root pass. The welds would than be liquid penetrant inspected after completion of the welds in accordance with MIL-STD-271E and MIL-STD-278D using NAVSHIPS 0900-003-8000 Class 1 acceptance standards.

The remote control system was used with the 2124 prototype head during the acceptance tests. These tests indicated that the design and construction of the remote control unit were adequate.

EVALUATION OF FEASIBILITY STUDY

1. Justification

As the project proceeded, cognizant personnel concluded that the model 2124 had inherent drawbacks. The ability of the prototype head to complete reliable root passes was a significant advantage. There were, however, drawbacks to the 2-piece shaped "outserts": this is not an acceptable repair method because Navy approved joint designs have not yet provided allowances for use of devices like the "outserts"; the fit-up and tacking of the "outserts" can also present access problems; and a significant inventory of "outserts" would be required to enable Navy-wide use of this type of welding. It was concluded that the above drawbacks would minimized by the development of a miniaturized "cold" wire feed.

The Astro-Arc contract was therefore modified to include Manufacturing Technology (MT) funding for the feasibility study of a second generation prototype welding head suitable for the addition of a wire feed.

2. Deliverables

The following deliverables were added to the contract:

(1) Preliminary design for a second generation prototype head with partial view of arc and space to add motorized wire feed and arc control

(2) Navy owned power supply retrofitted for automatic wire feed and arc control

(3) A remote control for wire feed

3. Evaluation of Design of 2nd Generation Prototype Head

The feasibility of developing a second generation prototype welding head was demonstrated by the thirteen preliminary design drawings and assurance provided by Astro-Arc Inc. that a more conventional compact head could be built. These drawings, No. 2124 sheets 1-13 are on file with NAVSSES Code 032D Attn. Mr. L. Wagner. Astro-Arc also supplied drawing SK-441 sheet 1 that shows how a miniaturized wire feed would be added to the unit. Figure 8 shows one view from SK-441.

Astro-Arc Inc. added a control for wire feed systems to the remote control developed for the 2124 prototype. Effective operation of the wire feed was demonstrated during the acceptance test for the prototype. A satisfactory test weld was completed using a commercially available Astro-Arc WF/AFC head connected to the remote control and remote wire feed control.

The preliminary design for the second generation head was for the same boiler and included many of the top level requirements used in the design of the 2124 prototype. The axial length of the second generation preliminary design was, however, reduced from 14 to 5-1/4 inches.

BENEFITS

The program was promoted initially because several welding specialists were pleased with state-of-the-art automatic orbital welders and wanted compact units for critical hard-to-reach pipe and tube joints. The preliminary economic justification for extending the development of the Compact Automatic Orbital Weld Head (CAOWH) for shipboard economizer "U" bends was predicted on estimated reductions in welding time per joint and the elimination of post repair leaks. These savings, when extended over the population of economizer tubes and based on frequency of repair, were adequate to justify MT funding. There are additional boiler related factors that favor the need for CAOWHs in the next few years. There is a planned retubing of the economizers of many of the boilers of Combustion Engineering manufacture where all the 1-1/2-inch tubes will be replaced with 2-inch tubes. A high population of steamships with approximately 20 years of service suggests a pending surge in the retubing of economizers. There is a consensus that once a successful design is developed for economizer "U" bends it should be relatively easy for competent equipment manufacturers to generate and guarantee specific orbital heads essentially on demand.

CONCLUSIONS

The following conclusions were reached:

(1) Test welds with a prototype automatic orbital welder demonstrated that hard-to-reach joints at economizer "U" bends could be effectively welded using a simplified, miniaturized, automatic orbital weld head.

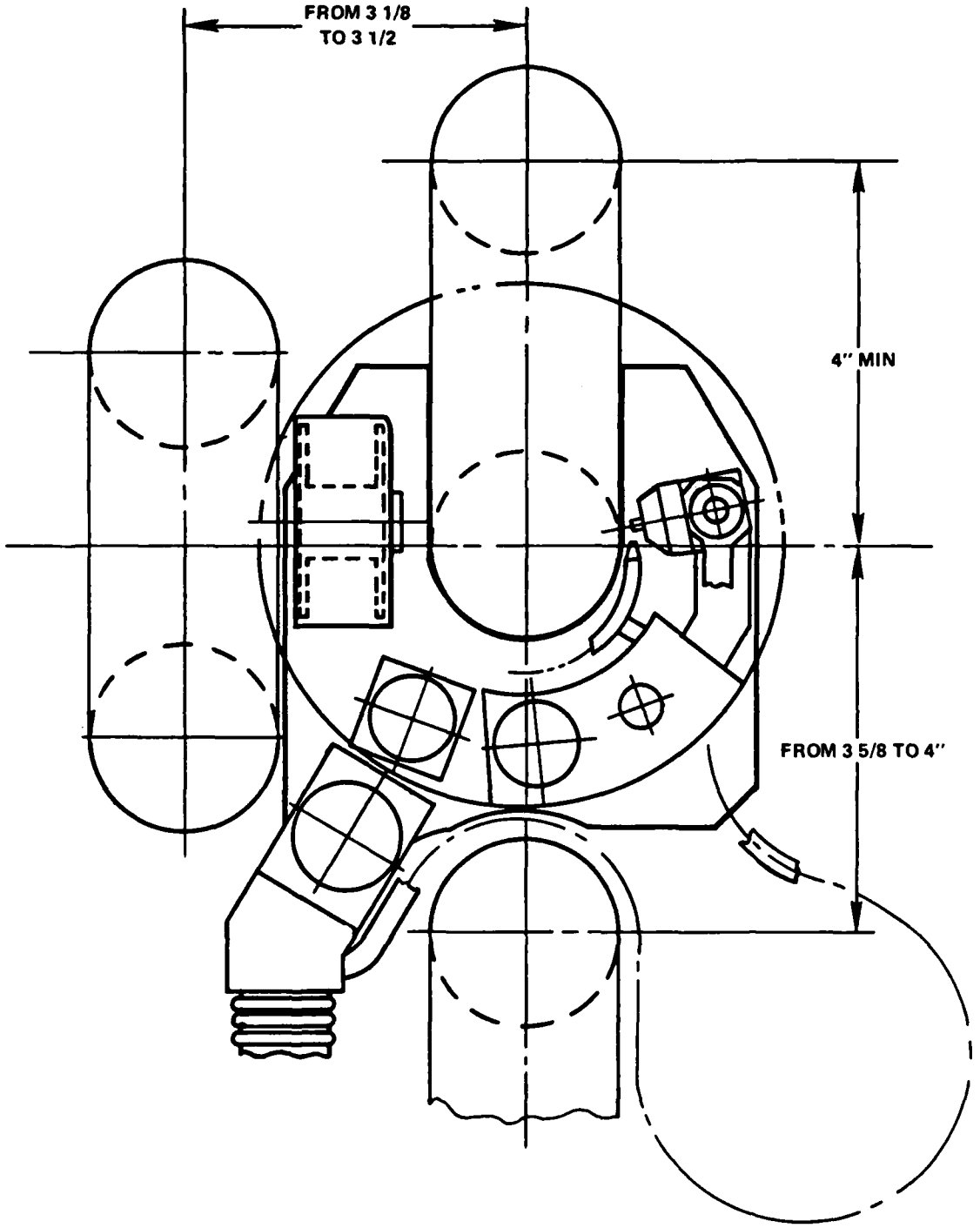

Figure 8. End view from Astro-Arc Dwg. SK-441 showing wire feed for "feasibility study"

(2) Based on this prototype, the feasibility study demonstrated how a more conventional orbital welding head could be built by incorporating a miniaturized wire feed system for the fill pass(es). This system would minimize the Navy's concerns with the proposed use of specially shaped "outserts" as required for making pipe/tube welds with the prototype.

(3) Private industry has the ability to produce specific automatic orbital welding heads for space limited application. Such heads have critical but limited Navy applications but little application outside the Navy. The development of such heads is therefore considered "beyond the risk of industry" and appropriate for MT funding.

(4) There are many tangible and intangible benefits from specific developments of automatic welding systems. However, significant costs will be required for development, purchase and maintenance of hardware and developing and qualifying the procedures. It is therefore necessary to detail the costs and benefits and to develop a plan for optimum utilization of an advanced design orbital weld head before proceeding with the preparation of a development contract for a second generation prototype.

FUTURE WORK

A continuation of this project was funded in April 1984 under the Manufacturing Technology (MT) Program and entitled: "Compact Automatic Orbital Welding Head (CAOWH)". This project, MT Project NO. DNS-50013, will result in an advance design head which will include cold wire feed and eliminate the need for inserts and "outserts". The tasks considered for the MT project include:

(1) Qualification testing of the prototype weld head (Astro-Arc Model 2124) as funding permits.

(2) Determine paramenters - tube size, spacing, stub length, tube to casing clearances - that need to be met for a CAOWH to be applicable to more than 90 percent of the economizer in fleet boilers.

(3) Develop consensus specifications for the more advanced design weld head for welding economizer "U" bends.

(4) Proceed with the development of the advanced design weld head in accordance with the concensus specification.

(5) Qualify the advance design weld head through a pilot Naval Shipyard.

(6) Provide a pre-production head for use at (a) Naval Shipyard(s) and distribute a complete technical data package.

APPENDIX A

OPERATION PROCEDURE FOR MODEL 2124 WELDING HEAD

(Obtained from Astro-Arc Inc.
Report of 7 Aug 83)

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APPENDIX "A"

OPERATION PROCEDURE FOR MODEL 2124 WELDING HEAD

PREPARING WELDING HEAD

1. Remove tube clamp housing (Fig. 1 #4-7) from lower housing assembly (Fig. 1).
2. Jog gear (Fig. 1, #29) 180^{o} to gain access to electrode set screw (Fig. 1, #26).
3. Insert tungsten electrode (Fig. 1, #31) into gear (Fig.1, #29) so that flat end of electrode is flush with gear O.D. For root pass use long (.755) electrode, for fill passes use short (.630) electrode. Tighten set screw (Fig. 1, #26) to hold electrode in place.
4. Jog gear (Fig. 1, #29) 180^{o} so that it is back in the starting position.

U-BEND WELD PREPARATION

1. Bevel pipe ends per specifications. Pipe ends should be clean and dry.
2. Place E.B. insert rings in U-Bend ends and align U-Bend onto straight pipe ends.
3. Tack weld in place, using back purge. Recommended: Three(3) ⅛" long tack welds, 120^{o} apart, using 60A welding current.

ALIGNING WELDING HEAD ON WELD JOINT

1. Attach alignment tool to tube clamp housing, on same side as alignment pins (Fig. 1, #9).
2. Position tube clamp housing on pipe, offset from weld (away from U-Bend) so that alignment tool plunger seats into weld joint. Upper clamp plungers (Fig. 1, #3) must point towards U-Bend. Orient tube clamp housing as shown in Figure 3.
3. Clamp tube clamp housing in place and remove alignment tool.
4. Attach welding head housing assembly to tube clamp housing assembly by butting end of lower housing assembly against tube clamp housing assembly, and hand tightening knurled screw (Fig. 2, #19). Be sure that hooks (Fig. 2, #9) seat onto dowel pins (Fig. 1, #10).
5. Close closure assembly doors (Fig. 2, #13-14). Make sure doors are fully closed.

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APPENDIX "A"

MAKING THREE PASS WELD

1. Weld root pass per weld schedule*. Back purge.
2. Remove entire welding head assembly (including tube clamp housing assembly).
3. Place outsert ring halves in place so that longer lip points towards U-Bend. Tack ring ends together (requires filler metal addition). DO NOT tack ring edges to pipe.
4. Replace long electrode with short electrode.
5. Attach alignment tool to tube clamp housing, on same side as alignment pins (Fig. 1, #9).
6. Position tube clamp housing on pipe, offset from weld (away from U-Bend) and align for first fill pass. Upper clamp plungers (Fig.1, #3) must point towards U-Bend. Orient tube clamp housing as shown in Figure 3.
7. Clamp tube clamp housing in place, and remove alignment tool.
8. Attach welding head housing assembly to tube clamp housing assembly by butting end of lower housing assembly against tube clamp housing assembly, and hand tightening knurled screw (Fig. 2, #19). Be sure that hooks (Fig.2, #9) seat onto dowel pins (Fig. 1, #10).
9. Close closure assembly doors (Fig. 2, #13-14). Make sure doors are fully closed.
10. Weld first fill pass per weld schedule*. Back purge.
11. Remove entire welding head assembly (including tube clamp housing assembly).
12. Attach alignment tool to tube clamp housing, on same side as alignment pins (Fig. 1, #9).
13. Position tube clamp housing on pipe, offset from weld (away from U-Bend) and align for second fill pass. Upper clamp plungers (Fig. 1, #3) must point towards U-Bend. Orient tube clamp housing as shown in Figure 3.
14. Clamp tube clamp housing in place and remove alignment tool.

*See Appendix B

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APPENDIX "A"

MAKING THREE PASS WELD(continued)

15. Attach welding head housing assembly to tube clamp housing assembly by butting end of lower housing assembly against tube clamp housing assembly, and hand tightening knurled screw (Fig. 2, #19). Be sure that hooks (Fig. 2, #9) seat onto dowel pins (Fig. 1, #10).
16. Close closure assembly doors (Fig. 2, #13-14). Make sure doors are fully closed.
17. Weld second fill pass per weld schedule*. Back purge.
18. Remove entire welding head assembly (including tube clamp housing assembly).

*See Appendix B

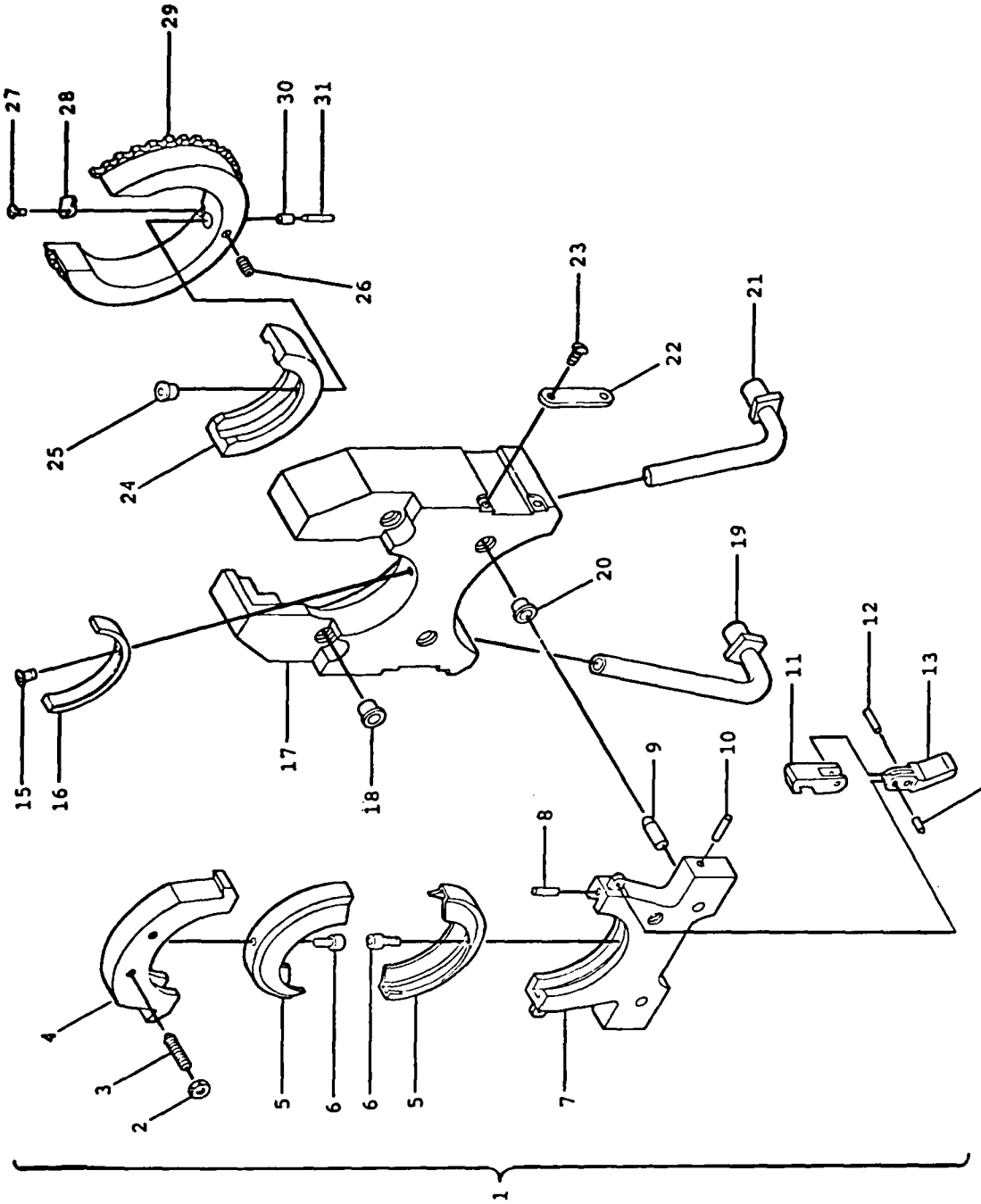


Figure 1. Lower Housing Assembly Special Open End Weld Head

APPENDIX "A"

MODEL 2124
SPECIAL OPEN END WELD HEAD
PARTS LIST - FIGURE 1

FIND NO.	PART NO.	DESCRIPTION	QTY. REQ.
1	2124-1001	Tube Clamp Assembly	1
2	2124-139	Nut	2
3	2124-138	Plunger	2
4	2124-1003	Upper Clamp	1
5	K2000-702	Tube Clamp Insert	2
6	2124-1007	Socket Head Cap Screw	2
7	2124-1002	Lower Clamp	1
8	2124-1006	Dowel Pin	2
9	2046-412	Alignment Pin	2
10	2124-1005	Dowel Pin	2
11	K1500-601	Snap	2
12	K1500-609	Dowel Pin	2
13	K1500-602	Snap	2
14	K1500-6010	Dowel Pin	2
15	2124-139	Flat Head Screw	1
16	2124-206	Ring	1
17	2124-801	Lower Housing Assembly	1
18	2046-209	Bushing	2
19		Tube Water Out	1
20	2046-210	Bushing	2
21		Tube Water and Current In	1
22	2124-903	Retaining Plate	2
23	2124-107	Flat Head Screw	2
24	2124-203	Gas Cup	1
25	2124-112	Gas Cup Nut	1
26	2124-136	Socket Set Screw	1
27	2124-137	Flat Head Screw	1
28	2046-716	Stop	1
29	2124-202	Gear	1
30	K1500-507	Bushing	1
31		Electrode	

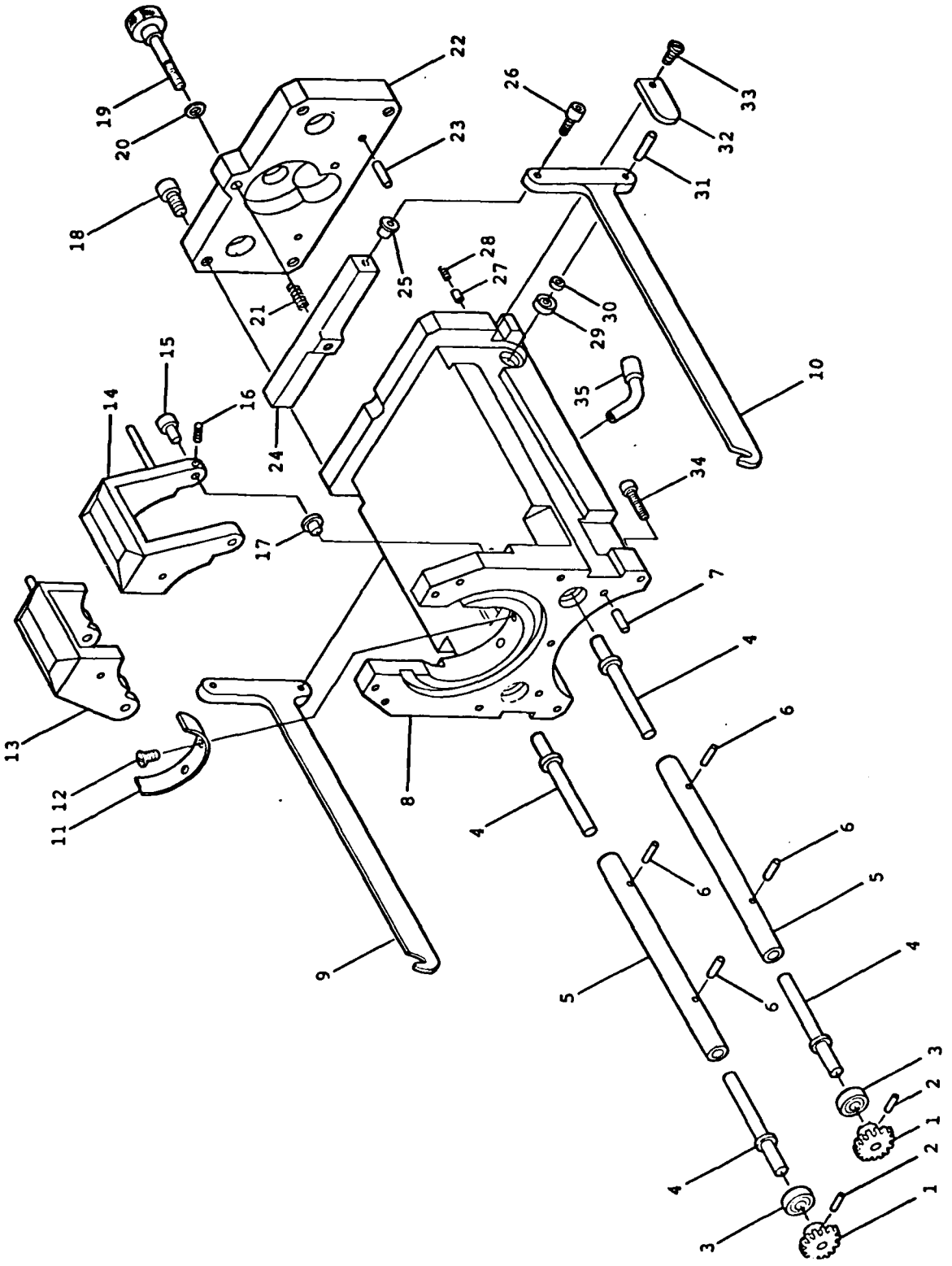


Figure 2. Upper Housing Assembly Special Open End Weld Head 2124

ASTRO-ARC CO.

MODEL 2124
SPECIAL OPEN END WELD HEAD
PARTS LIST - FIGURE 2

FIND NO.	PART NO.	DESCRIPTION	QTY. REQ.
1	2124-909	Spur Gear	2
2	2124-130	Dowel	2
3	2124-132	Ball Bearing	2
4	2124-504	Shaft	4
5	2124-505	Shaft	2
6	2124-506	Dowel	4
7	2124-302	Dowel	2
8	2124-401	Housing	1
9	2124-502	Hook	1
10	2124-501	Hook	1
11	2124-308	Ring	1
12	2124-139	Flat Head Screw	1
13	2124-905	Closure Assembly	1
14	2124-906	Closure Assembly	1
15	2046-612	Pin	4
16	2124-108	Socket Set Screw/Silver Tip	4
17	2046-209	Bushing	4
18	2124-104	Socket Head Cap Screw	4
19	2124-205	Screw	1
20	2124-120	Precision Washer	1
21	2124-119	Compression Spring	1
22	2124-303	Housing	1
23	2124-101	Dowel	2
24	2124-902	Retainer	1
25	2046-613	Bushing	2
26	2124-123	Shoulder Screw	2
27	2124-125	Dowel	2
28	2124-126	Compression Spring	2

STRO-ARC CO.

MODEL 2124
SPECIAL OPEN END WELD HEAD
PARTS LIST - FIGURE 2

FIND NO.	PART NO.	DESCRIPTION	QTY. REQ.
29	2124-121	Ball Bearing	2
30	2124-124	Shaft Spacer	2
31	2124-122	Dowel	2
32	2046-608	Retaining Plate	2
33	2124-127	Binding Head Screw	2
34	2124-116	Socket Head Cap Screw	2
35	2121-204	Tube - Gas In	1

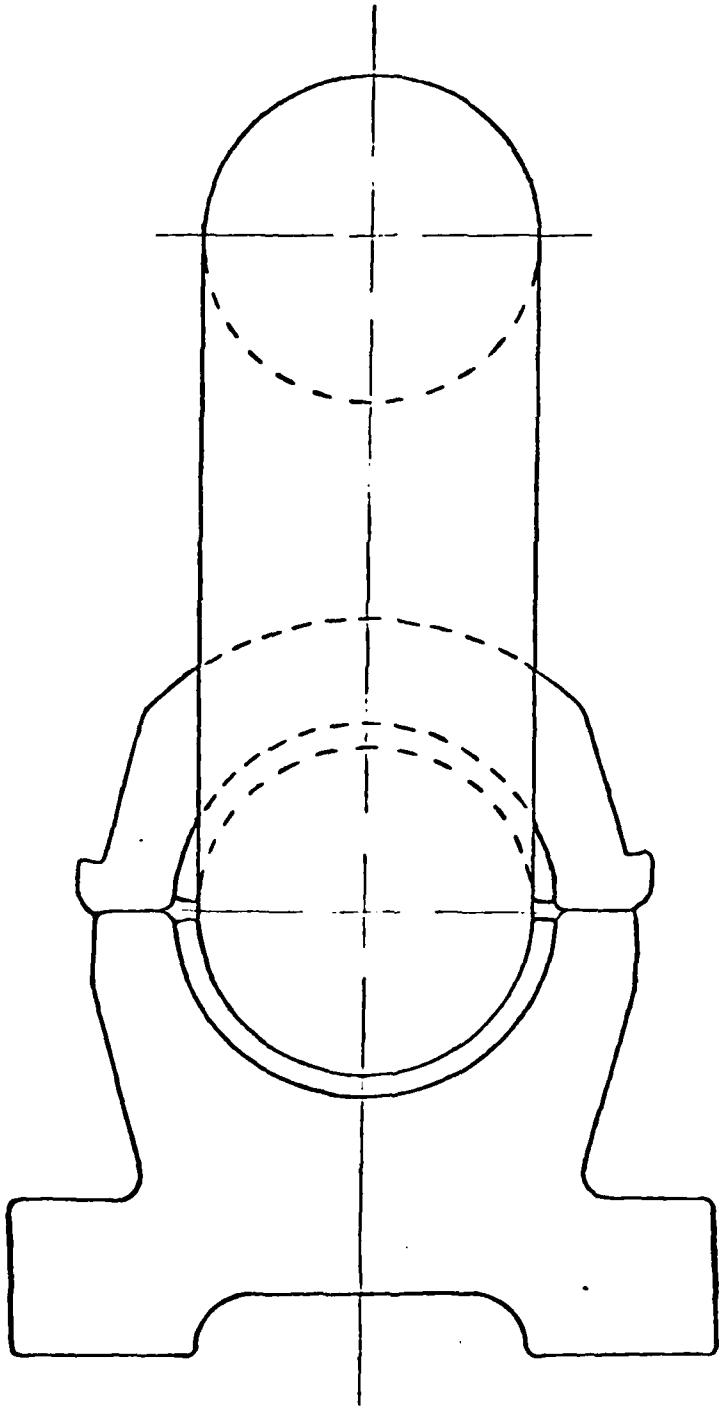


Figure 3. Tube Clamp Housing Orientation On Pipe

APPENDIX B

OPERATING DATA FOR TEST OF PROTOTYPE

APPENDIX "B"

CUSTOMER U.S. NAVY

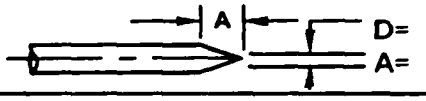
WELD SCHEDULE NO. ROOT PASS

DATE PREPARED:

TUBE ALLOY CARBON STEEL TYPE OF JOINT E.B. INSERT RING

PIPE O.D. 2.000 WALL THICKNESS .180

WELDING HEAD MODEL 2124 ELECTRODE DIA. LENGTH .770 GAP



POWER SOURCE MODEL E-200-T4 ELECTRODE TIP

WELD LEVEL I	WELD LEVEL II	WELD LEVEL III	WELD LEVEL IV	PULSE LOW
85	1.35	120	120	45
1	2	3	4	5

LEVEL I TIME	LEVEL II TIME	LEVEL III TIME	LEVEL IV TIME	FINISH SLOPE
60	7	134	0	9.9
6	7	8	9	10

PULSE HIGH TIME	PULSE LOW TIME	ROTATION DELAY TIME	HEAD SPEED R.P.M.
1.3	1.0	1.0	100
11	12	13	14

PULSE	
STEP PULSE (EXCEPT FOR WELD LEVEL I)	✓
OFF (FOR WELD LEVEL I ONLY)	✓
ARC START POSITION	ANY
75% HELIUM ARC GAS CFH 25% ARGON	30
75% HELIUM BACK UP GAS CFH 25% ARGON	15
PURGE TIME (SEC.) POST:	45
PURGE TIME (SEC.) PRE:	15

N	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

NOTES

CUSTOMER U.S. NAVY

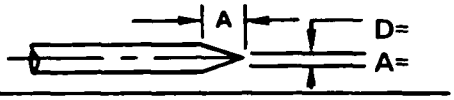
WELD SCHEDULE NO. 1ST FILL PASS

DATE PREPARED: _____

TUBE ALLOY CARBON STEEL TYPE OF JOINT OUTSERT RING

PIPE O.D. 2.000 WALL THICKNESS _____

WELDING HEAD MODEL 2124 ELECTRODE DIA. ____ LENGTH .640 GAP _____



POWER SOURCE MODEL E-200-T4 ELECTRODE TIP _____

WELD LEVEL I	WELD LEVEL II	WELD LEVEL III	WELD LEVEL IV	PULSE LOW
112	112	112	112	50
1	2	3	4	5

LEVEL I TIME	LEVEL II TIME	LEVEL III TIME	LEVEL IV TIME	FINISH SLOPE
50	50	50	50	9.9
6	7	8	9	10

PULSE HIGH TIME	PULSE LOW TIME	ROTATION DELAY TIME	HEAD SPEED R.P.M.
0.7	0.7	0.5	0.80
11	12	13	14

PULSE	
STEP PULSE	✓
OFF	
ARC START POSITION	ANY
75% HELIUM ARC GAS CFH 25% ARGON	30
75% HELIUM BACK UP GAS CFH 25% ARGON	15
PURGE TIME (SEC.) POST:	45
PURGE TIME (SEC.) PRE:	15

N	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								

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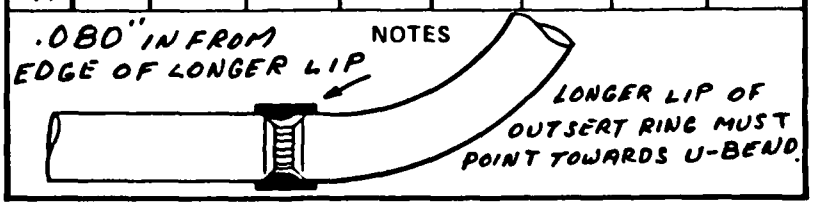


APPENDIX "B"

CUSTOMER U.S. NAVY

WELD SCHEDULE NO. 2ND FILL PASS

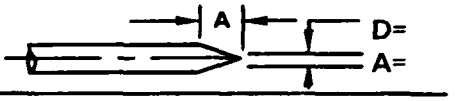
DATE PREPARED: _____

TUBE ALLOY CARBON STEEL TYPE OF JOINT OUTSERT RING

PIPE O.D. 2.000 WALL THICKNESS _____

WELDING HEAD MODEL 2124 ELECTRODE DIA. _____ LENGTH .640 GAP _____

POWER SOURCE MODEL E-200-T4 ELECTRODE TIP _____



WELD LEVEL I	WELD LEVEL II	WELD LEVEL III	WELD LEVEL IV	PULSE LOW
130	130	130	130	50
1	2	3	4	5

LEVEL I TIME	LEVEL II TIME	LEVEL III TIME	LEVEL IV TIME	FINISH SLOPE
50	50	50	50	9.9
6	7	8	9	10

PULSE HIGH TIME	PULSE LOW TIME	ROTATION DELAY TIME	HEAD SPEED R.P.M.
0.8	0.7	0.5	080
11	12	13	14

PULSE	
STEP PULSE	✓
OFF	
ARC START POSITION	ANY
75% HELIUM ARC GAS CFH 25% ARGON	30
75% HELIUM BACK UP GAS CFH 25% ARGON	15
PURGE TIME (SEC.) POST:	45
PURGE TIME (SEC.) PRE:	15

N	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5								
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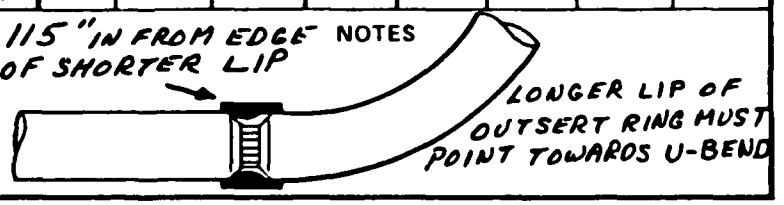
8								
9								
10								
11								
12								
13								
14								

NOTES



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